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ABSTRACT

The Mathematics Basic Skills Development Project served 15 secondary school locations in the Minneapolis Public Schools' Target Area in 1972-73. The objectives of this project were to develop and use an instructional system which would enable low achieving secondary students to learn basic mathematical concepts and skills. An instructional unit was to be considered successful if over 50 percent of the students who studied it achieved mastery (85 percent or more correct) on a criterion-referenced posttest. Instructional materials to be used in an individualized setting for the remediation of deficiencies in mathematics basic skills were developed, revised, and produced by the project following precise behavioral objectives. In this third year of the project, 2,128 secondary students and 38 teachers made use of the project's revised materials. Four instructional units were given preliminary trials, and revision was indicated for two of the four units. More than 2,100 students completed 6,937 units in 11 instructional areas. Over 50 percent of the students completing units in each area achieved mastery as shown by criterion-referenced posttests. Percents of students achieving mastery ranged from 52 percent in Area Measurement to 85 percent in Dividing Fractions. These were all students who had been below the mastery level on diagnostic tests of these mathematics basic skills. Recommendations are given. (Author)

Minneapolis Public Schools

Mathematics Basic Skills Development Project
Minneapolis, 1972-73

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Sara H. Clark, Title I Evaluator

Ideas expressed in this report do not necessarily reflect the official position of the Minneapolis Public School Administration nor the Minneapolis School Board.

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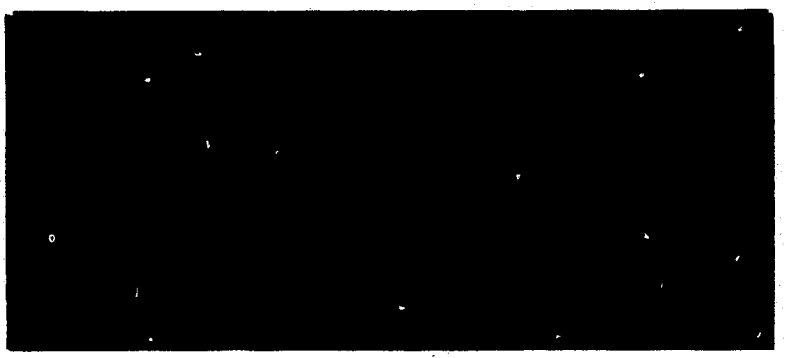

MINNEAPOLIS PUBLIC SCHOOLS

Special School District No. 1

Minneapolis, Minnesota 55413

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Minneapolis Public Schools

Mathematics Basic Skills Development Project
1972-73

Summary

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Research and Evaluation Department
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The City of Minneapolis

The program described in this report was conducted in the Minneapolis Public Schools. Minneapolis is a city of 434,400 people located on the Mississippi River in the southeastern part of Minnesota. With its somewhat smaller twin city, St. Paul, it is the center of a seven-county metropolitan area of over 1,874,000, the largest population center between Chicago and the Pacific Coast. As such it serves as the hub for the entire Upper Midwest region of the country.

The city, and its surrounding area, long has been noted for the high quality of its labor force. The unemployment rate in Minneapolis is lower than in other major cities, possibly due to the variety and density of industry in the city as well as to the high level capability of its work force. The Twin City metropolitan area unemployment rate in June of 1973 was 3.3%, compared with a 4.8% national rate for the same month. As the economic center of a prosperous region rich in such natural resources as forests, minerals, water power and productive agricultural land, Minneapolis attracts commerce and workers from throughout the Upper Midwest region. Many residents are drawn from the neighboring states of Iowa, Wisconsin, Nebraska and the Dakotas as well as from the farming areas and the Iron Range region of outstate Minnesota.

More Minneapolitans (32%) work in clerical and sales jobs than in any other occupation, reflecting the city's position as a major wholesale-retail center and a center for banking, finance and insurance. Almost as many (26%) are employed as craftsmen, foremen and operatives, and 23% of the work force are professionals, technicians, managers, and officials. One out of five workers is employed in laboring and service occupations.

Minneapolis city government is the council-dominated type. Its mayor, elected for a two year term, has limited powers. Its elected city council operates by committee and engages in administrative as well as legislative action.

Minneapolis is not a crowded city. While increasing industrial development has occupied more and more land, the city's population has declined steadily from a peak of 522,000 in 1950. The city limits have not been changed since 1927. Most homes are sturdy, single family dwellings built to withstand severe winters. Row homes are practically non-existant even in low income areas. In 1970, 48% of the housing units in Minneapolis were owner-occupied.

Most Minneapolitans are native born Americans, but about 35,000 (7%) are foreign born. Swedes, Norwegians, Germans, and Canadians comprise most of the foreign born population.

Relatively few non-white citizens live in Minneapolis although their numbers are increasing. In 1960 only three percent of the population was non-white. The 1970 census figures indicate that the non-white population had more than doubled (6.4%) in the intervening 10 years. About 70% of the non-whites are black. Most of the remaining non-white population is American Indian, mainly Chippewa and Sioux. Only a small number of residents from Spanish-surnamed or Oriental origins live in the city. In 1970 non-white residents made up 6.4% of the city's population but accounted for 15% of the children in the city's elementary schools.

Minneapolis has not reached the stage of many other large cities in terms of the level of social problems. It has been relatively untouched by racial disorders or by student unrest. Crime rates are below national averages.

One's first impression is that Minneapolis doesn't really have serious problems of blight and decay. But the signs of trouble are evident to one who looks beyond the parks and lakes and tree-lined streets. As with many other larger cities, the problems are focused in the core city and are related to increasing concentrations there of the poor, many of them non-whites, and of the elderly. For example, nine out of 10 black Americans in Minneapolis live in just one-tenth of the city's area. While Minneapolis contains 11% of the state's population, it supports 28% of the state's AFDC families.

There has been a steady migration to the city by American Indians from the reservations and by poor whites from the small towns and rural areas of Minnesota. They come to the "promised land" of Minneapolis looking for a job and a better way of life. Some make it; many do not. The American Indian population is generally confined to the same small geographic areas in which black Americans live. These same areas of the city have the lowest median incomes in the city and the highest concentrations of dilapidated housing, welfare cases, and juvenile delinquency.

The elderly also are concentrated in the central city. In 1970, 15% of the city's population was over age 65. The elderly, like the 18 to 24 year old young adults, live near the central city because of the availability of less expensive housing in multiple-unit dwellings. Younger families have continued to migrate toward the outer edges of the city and to the surrounding suburban areas.

The Minneapolis Schools

About 69,477 children go to school in Minneapolis. Most of them, about 61,052, attend one of the city's 98 public schools; 8,425 attend parochial or private schools.

The Minneapolis Public Schools, headed by Dr. John B. Davis, Jr., who became superintendent in 1967, consists of 67 elementary schools (kindergarten-6th grade), 15 junior high schools (grades 7-9), nine high schools (grades 10-12), two junior-senior high schools, and five special schools. Nearly 3,500 certificated personnel are employed.

Control of the public school system ultimately rests with a seven-member board which levies its own taxes and sells its own bonds. These non-salaried officials are elected by popular votes for staggered six-year terms. The superintendent is selected by the board and serves as its executive officer and professional adviser.

Almost 40 cents of each local property tax dollar goes to support a school system whose annual operating general fund budget in 1973-74 is $81,038,330 up from $78,992,236 in 1972-73. Minneapolis received federal funds totaling 11.8 million dollars in 1972-73 from many different federal aid programs. The Elementary and Secondary Education Act provided about 6.5 million dollars, of which 3.4 million dollars were from Title I funds. The adjusted maintenance cost per pupil unit in the system was $981 in 1971-72 while the range of per pupil unit costs in the state for districts maintaining elementary and secondary schools was from $563 to $1,324.

One of the superintendent's goals has been to achieve greater communication among the system's schools through decentralization. Initially, two "pyramids" or groups of geographically related schools were formed. First to be formed, in 1967, was the North Pyramid, consisting of North High School and the elementary and junior high schools which feed into it. In 1969 the South-Central Pyramid was formed around South and Central High Schools. Each pyramid had an area assistant superintendent as well as advisory groups of principals, teachers, and parents. The goals of the pyramid structure were to effect greater communication among schools and between schools and the community, to develop collaborative and cooperative programs, and to share particular facilities and competencies of teachers.

In the summer of 1973 decentralization was carried one step further when the entire school district, with the exception of five schools involved in an experimental program called Southeast Alternatives, was divided into three areas.

Each of these areas -- East, West and North -- is headed by a superintendent who has autonomous decision-making power within the guidelines of school district policies and philosophies.

Based on sight counts on October 17, 1972 the percentage of black American pupils for the school district was 10.6%. Eight years before, the proportion was 5.4%. American Indian children currently comprise 3.8% of the school population, more than double the proportion of eight years ago. The proportion of minority children in the various elementary schools generally reflects the prevailing housing pattern found in each school area. Although some non-white pupils are enrolled in every elementary school, non-white pupils are concentrated in two relatively small areas of the city. Of the 67 elementary schools, 11 have more than 30% non-white enrollment and four of these have over 50%. There are no all-black nor all-white schools. Twenty-three elementary schools have non-white enrollments of less than 5%.

The Minneapolis School Board has approved a desegregation plan involving busing which has operated smoothly since taking effect in September 1973.

The proportion of school age children in AFDC homes has more than doubled from approximately 12% in 1962 to 28% in 1972.

While the median pupil turnover rate for all the city schools in 1971-72 was about 24.5%, this figure varied widely according to location (turnover rate is the percentage of students that comes new to the school or leaves the school at some time during the school year, using the September enrollment as a base figure). Target Area schools generally experience a much higher turnover rate; in fact only four of the Target Area schools had turnover rates less than the city median. Compared with the city, the median for the Target Area schools was 36.1%.

The Target Area

The Target Area is a portion of the core city of Minneapolis where the schools are eligible to receive benefits from programs funded under Title I of the Elementary and Secondary Education Act (ESEA). A school is eligible to receive Title I aid if the percentage of families residing in that school's district which receives AFDC payments (in excess of $2,000 a year) -- or has an annual income under $2,000 -- exceeds the citywide percentage for families in those categories.

In 1972-73, nearly 26,871 children attended the 25 elementary schools, five junior highs, three senior highs and seven parochial schools that were eligible to receive this aid. One-third of these students were from minority groups and one-third were defined by the State Department of Education as

educationally disadvantaged, i.e. one or more grade levels behind in basic skills such as reading and arithmetic. Federal programs are concentrated on the educationally disadvantaged group.

According to 1970 census data, over 170,000 persons resided in the Target Area. Of that group, 11 percent were black and 3½ percent were Indian, more than double the citywide percentage of minority group members. Over half of the Target Area residents over 25 years old had not completed high school, compared to the 35 percent of the non-Target Area residents who did not have high school diplomas. One out of five Target Area residents over the age of 25 had gone to college, and nine percent had completed four or more years. One out of four of the non-Target Area residents had gone to college, and 15 percent had completed four or more years.

The income for an average Target Area family was $9,113 in 1970, about $2,000 less than the citywide average. The homes they lived in had an average value of $10,385, over 40 percent less than the average value of a single family residence in Minneapolis. One out of five Target Area children between the ages of 6 and 17 was a member of a family that was below the poverty level, while only 6 percent of the non-Target Area children had such a family status.

Historical Background

The secondary public schools in Minneapolis, beginning in 1968, had the use of an excellent system for diagnosing student deficiencies in mathematics basic skills. This system was called the Arithmetic Test Generator (ATG). It was based on precise behavioral definitions of mathematics basic skills (item forms). Equivalent test items could be randomly generated from these forms. This system was stored in a central computer at Honeywell. Secondary teachers had access to this system through computer terminals in each school building. The ATG could thus be used to diagnose in detail the computational difficulties of any secondary student. Tests keyed to the ATG system given in the fall of 1969 to all 8th grade students showed that improved instruction was needed in the basic skills of mathematics. The teachers reported, however, that they were lacking the instructional materials to remedy the identified deficiencies.

The Mathematics Basic Skills Development Project was initiated to select and develop suitable instructional materials for use with the ATG system. The project began in October 1970 with funding of $31,000 from Title I (ESEA) for its first year of operation.

Mathematics teachers in the Target Area junior high schools have participated in all phases of the project. They have selected and defined objectives, written materials, and finally tried and tested new units as they were developed with their students. Many of the teachers had excellent ideas for new materials but had previously lacked the resources to implement them.

By the end of the school year 1970-71, three units had been used in classrooms with complete results from 172, 36, and 13 students for the different units. The evaluation[1] of the first year of the projects' operation concluded, "All test results were positive and at least indicate an exciting potential for the development of materials to support the mathematics curriculum."

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[1] Educational Management Services, Inc. An Evaluation of the Minneapolis Mathematics Basic Skills Development Project. Minneapolis: Educational Management Services, Inc., 1971.

In 1971-72, the second year of the project, over 1,000 copies of 10 different units were used by 586 junior high students. Units were assigned to pupils who were found to be deficient in certain basic mathematical skills. Instructional materials dealing with fractions and with the division of whole numbers were more frequently assigned than were those dealing with decimals, percent, or measurement. Mastery (defined as 85% or more correct) was achieved on eight of the ten units by from 55% to 74% of the students. Writing teams of mathematics teachers made use of test item analyses, not only for the revision of the two weaker units and tests but also for minor revisions in the more successful materials. Continuation of the project was recommended.[2]

The Project Schools

The Mathematics Basic Skills Development Project served five junior high schools and three senior highs in the 1972-73 school year. These were all the secondary schools designated as Target Area and eligible for Title I funds in 1972-73. In addition, one parochial school and six special locations in the Target Area received services from the project. The participating schools are listed in Table 1.

The neighborhoods in which these schools are located are described in the preceding section on the target Area of Minneapolis. Each of the neighborhoods varies in some respects, but the overall picture is a good general description of the backgrounds of many of the students. The schools which were in the project, with the exception of Sheridan, all had attendance rates below the 1972-73 Minneapolis secondary schools total rate of 90%. The average turnover rate of the student population in these schools was higher than the average of all Minneapolis secondary schools.

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[2] Clark, S. H. Mathematics Basic Skills Development Project, 1971-72. Minneapolis: Minneapolis Public Schools, 1973.

Table 1

Participating Schools

Junior High

Bryant
Franklin
Lincoln
Phillips
Sheridan

Senior High

Central
North
South

Parochial

Holy Rosary

Special Locations

Bryant YES Center
Center School (South Free)
Loring-Nicollet
North Side Street Academy
Phillips-Messiah
St. Anthony School
Rehabilitation Center (SRC)

The special locations which made use of the project's units were all in the Target Area. Students who attended them were mostly youngsters who had found it difficult to adapt to the regular school situations for one reason or another, and who would normally have been attending a Target Area secondary school.

Objectives

General goals and specific objectives were defined for two phases of the Mathematics Basic Skills Development Project for 1972-73.

The developmental phase was to continue the development of an instructional system which would enable low achieving secondary students to learn basic mathematical concepts and skills. The four areas in which new units and materials were to be developed were: Addition and Subtraction of Decimal Numbers, Multiplying Decimal Numbers, Dividing Decimal Numbers, and Liquid Measurement. Each unit was to be defined by precise behavioral objectives written by the project leaders and mathematics teachers from Target Area Schools. A new unit was to be considered effective if at least 50% of the students who completed it achieved mastery (85% or more correct) on the criterion-referenced posttest. The figure of 85% was somewhat arbitrary but was selected since it had been widely used in the field of criterion-referenced testing. Title I Guidelines required that,

at the secondary level, at least 50% of the pupils attain the project's objectives if the project were to be considered for continuation.

The implementation phase consisted of the remediation of specific weaknesses in the basic skills of mathematics of Title I (ESEA) secondary students by use of materials which the project had developed and revised in its two previous years of existence. The program could be considered successful, according to state Title I guidelines, if at least 50% of the students who needed remediation in a given area, as shown by pretests, achieved mastery, as indicated by posttests, after completing the unit and materials covering that area.

Personnel

The project leader, since the beginning of the project, has been a teacher on special assignment. She held a Master's degree in mathematics education, and had four years of experience in writing math materials for different curriculum development projects including the Job Corps. Her primary responsibilities were planning the writing sessions, supervising the selection and writing of objectives, and assembling resource materials for the writers. She made all final editorial decisions, was in charge of the art work, and assisted in planning the evaluation of the project. Administrative responsibilities included budget planning, arranging for reproduction of materials, and clerical supervision. In 1972-73 she was on a half-time assignment.

The other project leader was also a teacher on special assignment whose Bachelor's degree was in mathematics education. He had previously taught mathematics for six years at one of the project schools (including three years as department chairman), and worked on curriculum writing teams with the Minneapolis Schools' mathematics consultant. At the beginning of the project he was on the first writing team, then remained as assistant leader for the second year, and became co-leader for the third year. He continued teaching two math classes at a project school while working .6 time on

the project. This arrangement was especially helpful in that he could try some of the materials and procedures in his classroom before they were distributed on a wider scale.

A team of eight secondary teachers worked in writing workshops held during school vacation periods and over the summer. They had all taught math successfully in Target Area secondary schools and had shown creativity in developing and writing instructional materials. Their experiences in the inner city schools made them especially qualified for these positions.

Supplemental services were received from the secondary mathematics consultant for the Minneapolis Public Schools. He provided assistance in planning the overall goals of the project and supported and promoted its activities.

A full time clerk-typist (I) was also on the project staff.

Planning and Training

Project planning was continuous in that new materials were written and revisions were made of previously developed materials. The project leaders planned the project activities on the basis of test results, item analyses, and comments from Target Area math teachers and students who were using the project's units. All plans were reviewed with the teachers before implementation.

Once the areas for which new units of instruction were to be written had been defined, further detailed planning took place. Specific performance objectives were written for each area. An example of such an objective for the unit on Decimal Concepts was "Given a three place decimal fraction with one or two zeros immediately after the decimal point, the student will write the corresponding common fraction." A sample test item was provided for each objective. The illustrative item for the above objective was "Write as a fraction: .002 = _(2/1000)."

The original objectives were often modified somewhat as the units were written. However, they served as guidelines for the writers so that each unit was designed to teach all the objectives in a given area. Supplementary materials were also developed which could be used if students needed additional

help in learning. One diagnostic pretest and three parallel posttests were written for each unit. Each test was so constructed that in general it tested performance of each objective once. Inservice meetings were held to familiarize teachers with new materials as they were produced.

A two-day preservice training session was given on August 29-30 for Title I teacher aides and the secondary teachers with whom they were to work in 1972-73. It was conducted by the staff of the Mathematics Basic Skills Development Project. An additional half-day inservice training session for the aides was held in October so information on the program's progress could be exchanged, questions answered, and needs for resource help could be identified. The ten aides who attended the October session were asked to complete Evaluation of Professional Growth Course forms. They rated the contents of the course as very or extremely relevant, said that they would use the new materials and approaches either quite a bit or a great deal, and rated the course as very worthwhile. The method of presentation was rated as excellent by seven of the aides and above average by the others.

A course for aides presented by the project leader was completed by one aide from each of six of the eight participating public schools. The course included demonstrations of manipulative devices and materials, explanations of basic mathematical concepts, and a refresher course in the computational skills necessary to the program. All aides showed improvement from pre- to posttest in those skills except one who had already scored 100% on the pretest. Very favorable ratings were given to the content of this course and the methods of presentation. The aides thought it was "very" worthwhile.

Parent and Community Involvement

There was no direct parent or community involvement in either the development or implementation of this project.

Dissemination and Communications

The staff continued to make presentations at both public and professional meetings as they had done in previous years. A brochure describing the project was widely distributed in response to inquiries received from Minneapolis and many other cities. The first page of the brochure is shown in Appendix A.

Various exhibits and slides made by the project staff were used in the presentations given by the project leaders. All of them are available upon request.[3]

Budget

The project leaders were responsible for the expenditures for this program under approval of the Federal Projects Office of the Minneapolis Public Schools. The funds provided by Title I were budgeted as shown in Table 2.

Table 2

Budget for September 1, 1972-August 31, 1973.

	Dollars	%
Salaries (Includes 1000 hrs. Resource Teacher time in addition to regular staff)	$28,846	68
Instructional materials, printing, office supplies	7,900	19
Mileage, travel, and telephone	847	2
11% fringe on salaries	3,173	8
Instructional and office equipment	1,450	3
	$42,216	100%

An average cost per pupil can be figured on the basis of the 2,128 students who used the units developed by the project. It amounts to $19.84. This figure includes the developmental costs of writing new materials and ignores the varying numbers of units which were taken by different students.

[3] Mathematics Basic Skills Development Project
2908 Colfax Ave. S., Minneapolis, Mn. 55408
Tel. (612)-348-4052.

Costs for maintaining the program for a particular student will be in the range of five to six dollars.

The budget given here was originally for the period from September 1, 1972 to August 31, 1973. Because of a change in accounting procedures the time span was shortened so that it ended June 30, 1973. The budget was adequate for the ten months but would not have sufficed for twelve months of operation.

Project Operations

This report covers the period from September 1972 through August 1973, the third year of the project's existence. The project office was located at the Lehmann Center, a Minneapolis Public School facility. The leaders, however, made numerous trips to the participating schools. No physical changes were required in either the office or the classrooms. Measuring instruments such as rulers were needed by the students for some of the measurement units.

The first step in producing an instructional unit was to select behavioral objectives--precise statements of what the student should be able to do after completion of the unit. Many of the original objectives had been selected from the Arithmetic Test Generator system (ATG) which was used by the Minneapolis school system at that time. When the project began developing materials outside the scope of the ATG, such as for measurement, the leaders and teachers on the writing team defined the objectives for each area.

A draft version of an instructional unit was written, then reviewed and revised by the team members. Four test items were written for each objective. The items were randomly assigned to a diagnostic test (pretest) and three forms of a unit test (posttest). Each test thus had one item for each objective specified for that area. In addition, supplementary puzzle materials to be used for extra remediation and review and teacher materials were written for each unit.

All materials were designed for use in an individualized instructional setting. Students worked independently at their own pace with a personal copy of the unit which they were allowed to keep. A student who was absent did not get behind; if students were especially interested they could take the units home with them. A unit might be completed in two or three periods or in several weeks, depending on both the topic and the particular student. Emphasis was placed on having activities and puzzles, a low reading level, and an appropriate combination of drill exercises and explanation. Cartoon characters were used to make the units look more appealing than standard textbooks.

Each unit was printed in a consumable booklet varying in length from 20 to 50 pages. The pupil used an answer key to check his or her work after every three to eight pages. After completion of the unit the student took one form of the posttest. If the material had been mastered the student could go on to another unit. If the posttest score was less than 85%, supplementary puzzle materials or teacher instruction were available. The student could then take another form of the posttest to prove mastery. Some teachers required mastery of an area before the pupil could progress to another unit. Others let the students go on while continuing to provide remedial materials.

After the units and accompanying tests had been tried out under normal classroom conditions, the results were studied by the project staff. Item analyses of all tests were provided. If the percentages correct for a given item were uniformly low on all test forms an effort was made to improve the unit's instruction for that objective. If the percentage correct for an item was noticeably low on only one or two test forms the test items were scrutinized to see how that particular item differed from the other "parallel" items. On the basis of these analyses, student reactions and teacher comments, the units and tests were then revised. Such analyses were made during the school year for the four units developed in 1972-73.

The materials so far developed by the project do not form a complete curriculum. They were intended for the remediation of deficiencies in specific mathematics basic skills. The eleven units in general use in 1972-73 pertained to fraction and decimal concepts, six different computational skills with fractions, and linear, area, and metric measurement. These materials had been tested and revised during the previous school year.

Participants

Students were defined as being Title I eligible for specific project materials if they were lacking in the particular skills taught by that material. Diagnostic tests based on precisely defined objectives had been constructed for each of the instructional units. The skills measured by the tests were generally skills which should have been learned in grades 4-6. Therefore, secondary students not achieving mastery on a diagnostic test were deemed to be at least one year below grade level in that particular area. Mastery on this criterion-referenced test was defined as answering at least 85% of the items correctly. Students who achieved mastery on a given diagnostic pretest were not eligible for that particular unit. All students included in this report were deficient in the areas for which results are given as measured by diagnostic tests.

A total of 2,128 students received services from the project in the implementation phase of the program. They were enrolled in eight public secondary schools, in one parochial school, and in six special locations which were related to the public schools in different ways. The special location sites were affiliated with various Minneapolis secondary schools. Their student populations were quite similar in many respects to those of the schools with which they were affiliated. Many of their students, however, had had problems in adjusting to the usual school situation and it was hoped that they might benefit from the educational programs which these special locations offered.

Thirty-eight teachers used the project materials with some or all of their students. The numbers of participating students and teachers are given by school in Table 3.

Table 3

Participating Students and Teachers
by School

	No. of Students	No. of Teachers
Junior High		
Bryant	188	3
Franklin	562	7
Lincoln	178	3
Phillips	416	6
Sheridan	71	3
Senior High		
Central	143	3
North	180	2
South	165	3
Parochial		
Holy Rosary	38	1
Special Locations		
Bryant YES Center	35	1
Center School (South Free)	41	2
Loring-Nicollet	29	1
North Side Street Academy	50	1
Phillips-Messiah	22	1
St. Anthony (SRC)	10	1
All schools and locations	2,128	38

Grade level information was received for only 75% of the students. Of the students whose grade level was known, one fourth were in the seventh grade and another fifth in the eighth grade. The full distribution by grade level is given in Table 4. The sexes were about evenly divided: 52% male and 48% female.

Table 4

Distribution by Grade Level
of Participating Students

Grade	N	% of Project
7	582	27
8	438	21
9	308	14
10	173	8
11	75	4
12	16	1
Not Known	536	25
Total	2,128	100%

Seven teachers each assigned the units to fewer than 25 students. One teacher used the materials with 188 students. Table 5 gives a distribution of teachers by numbers of participating students.

Table 5

Distribution of Teachers by Number of
Participating Students

Students	Teachers
Over - 125	3
101 - 125	1
76 - 100	4
51 - 75	9
26 - 50	14
0 - 25	7
Total	38

In the developmental phase, teachers in three of the participating junior highs, in two of the senior highs, and in one of the special locations tested the new units and materials with students in their classes. Five teachers assigned materials from all four of the new subject areas, six assisted in testing three of the new units, while six more teachers tried out the materials from one or two units. The grade level distribution of students in the "try-outs" was approximately the same as the grade level distribution of the students in the implementation phase of the project with roughly two-thirds of the target population at the junior high level.

Results: Developmental Phase

New units and materials in four areas were developed and tested by the project in 1972-73. They were:

1. Addition and Subtraction of Decimal Numbers
2. Multiplying Decimal Numbers
3. Dividing Decimal Numbers
4. Liquid Measurement

Distributions of the scores on the pretest and alternate forms of the posttests for these units are given in Tables 6 - 9. These data plus item analyses for all tests were given to the project leaders and the writing team at the end of the school year so that revision of the units, where necessary, could be done during the summer of 1973. The units which, according to the data, were most in need of revision were Dividing Decimal Numbers, on which 51% of the students achieved mastery, and Liquid Measurement, on which 49% reached that objective. The materials in the other two areas were more successful in the preliminary trials. Seventy-four percent of the students scored 85% or more correct after completing the unit on Addition and Subtraction of Decimals, and 80% achieved mastery in Multiplying Decimals. These scores were obtained by students who had previously been deficient in these skills as shown by diagnostic tests. The change in the shapes of the distributions from pretest to posttest should be noted in Tables 6 - 9.

Table 6

Addition and Subtraction of Decimal Numbers
Pre- and Posttest Scores
by Posttest Form
14 Items

Posttest Distributions by Form
(12 or more items needed for Mastery)

Percent Right:	Form A N	Form A %	Form B N	Form B %	Form C N	Form C %	All Forms N	All Forms %	Pretest Distribution N	Pretest Distribution %
Mastery: 85% or more	37	71	25	71	26	81	88	74	0	0
75 - 84	6	12	8	23	4	13	18	15	25	21
50 - 74	8	15	2	6	2	6	12	10	41	35
25 - 49	0	0	0	0	0	0	0	0	24	20
0 - 24	1	2	0	0	0	0	1	1	29	24
Total	52	100%	35	100%	32	100%	119	100%	119	100%

Means and Standard Deviations
by Posttest Form

	Form A	Form B	Form C	All Forms
Diagnostic Pretest				
Mean	5.27	6.66	7.72	6.34
S.D.	3.53	3.57	2.33	3.30
Posttest-by Form				
Mean	11.96	12.23	12.56	12.20
S.D.	2.43	1.65	1.74	2.05

Table 7

Multiplying Decimal Numbers
Pre- and Posttest Scores
by Posttest Forms
11 Items

Posttest Distributions by Form[a]
(9 or more items needed for mastery)

Percent Right	Form A N	Form A %	Form B N	Form B %	Form C N	Form C %	All Forms N	All Forms %	Pretest Distribution N	Pretest Distribution %
Mastery: 85% or more	27	87	16	70	24	80	67	80	0	0
75 - 84	2	6	4	17	2	7	8	10	4	5
50 - 74	2	6	2	9	1	3	5	6	15	18
25 - 49	0	0	0	0	2	7	2	2	20	23
0 - 24	0	0	1	4	1	3	2	2	46	54
Total	31	99%	23	100%	30	100%	84	100%	85	100%

[a]Posttest form not known for one student.

Means and Standard Deviations
by Posttest Form

	Form A	Form B	Form C	All Forms
Diagnostic Pretest				
Mean	3.13	2.04	3.03	2.79
S.D.	2.64	2.20	2.67	2.55
Posttest-by Form				
Mean	9.84	8.96	9.23	9.38
S.D.	1.21	2.01	2.60	2.02

Table 8

Dividing Decimal Numbers
Pre- and Posttest Scores
by Posttest Form
14 Items

Posttest Distributions by Form[a]
(12 or more items needed for mastery)

Percent Right	Form A		Form B		Form C		All Forms		Pretest Distribution	
	N	%	N	%	N	%	N	%	N	%
Mastery: 85% or more	21	51	17	54	15	48	53	51	0	0
75 - 84	9	22	3	10	8	26	20	19	7	7
50 - 74	6	15	4	13	7	23	17	17	13	13
25 - 49	2	5	4	13	0	0	6	6	19	18
0 - 24	3	7	3	10	1	3	7	7	65	62
Total	41	100%	31	100%	31	100%	103	100%	104	100%

[a]Posttest form not known for one student.

Means and Standard Deviations
by Posttest Form

	Form A	Form B	Form C	All Forms
Diagnostic Pretest				
Mean	3.33	3.77	2.97	3.36
S.D.	3.27	3.31	3.09	3.21
Posttest-by Form				
Mean	10.24	9.71	10.90	10.28
S.D.	3.29	4.14	2.40	3.35

Table 9

Liquid Measurement
Pre- and Posttest Scores
by Posttest Form
22 Items

Posttest Distributions by Form
(19 or more items needed for mastery)

Percent Right	Form A N	Form A %	Form B N	Form B %	Form C N	Form C %	All Forms N	All Forms %	Pretest Distribution N	Pretest Distribution %
Mastery: 85% or more	8	40	7	58	7	54	22	49	0	0
75 - 84	6	30	1	8	2	15	9	20	3	7
50 - 74	5	25	2	17	4	31	11	25	4	9
25 - 49	0	0	2	17	0	0	2	4	15	33
0 - 24	1	5	0	0	0	0	1	2	23	51
Total	20	100%	12	100%	13	100%	45	100%	45	100%

Means and Standard Deviatons
by Posttest Form

	Form A	Form B	Form C	All Forms
Diagnostic Pretest				
Mean	5.70	8.50	5.23	6.31
S.D.	3.28	5.81	4.30	4.47
Posttest-by Form				
Mean	16.65	17.08	17.54	17.02
S.D.	4.31	5.88	2.88	4.37

Results: Implementation Phase

The instructional materials in general use in 1972-73 were all effective in that the objective of having at least 50% of the students achieve mastery was more than met in each area. In seven of the eleven areas 70% or more of the students achieved mastery. A summary of the results is given in Table 10 in which Column E shows the percentage achieving mastery for each unit. Dividing Fractions was the unit which showed the largest percentage of students achieving mastery (85%) and Area Measurement had the smallest percentage (52%) who reached that goal.

Column A gives the number of students who took pretests in each area. Although 2,128 students received instructional materials from the project, it can be seen that not all the students were tested in any given area. The diagnostic tests were used in different ways by the teachers. Some gave a specific pretest to whole classrooms while others used the tests only for diagnosis with individual students whom they knew were having difficulties in a given area.

The figures in Column B (students who showed mastery on the pretest) therefore do not give a true picture of the previous mathematical knowledge of the 2,128 students in the project. The Column B figures were subtracted from the number of students with valid pretest scores to obtain the number of students who were eligible for the project as given in Column C. In some cases, Columns B and C do not sum to Column A. In some cases the score recorded for the student was above the highest possible score and so was ignored. There were, however, only 19 out of the 11,296 pretest scores which were discarded.

Table 10

Summary of Test and Unit Use and Mastery[a]

Unit Name (Items needed for Mastery/Items in test)	(A) Pretests Given N	(B) Pretest Mastery N	(B) Pretest Mastery %	(C) Eligible Students N	(D) Completed Unit N	(D) Completed Unit %	(E) Posttest Mastery N	(E) Posttest Mastery %
Fraction Concepts (17/20)	1791	314	18%	1475	1293	88%	974	75%
Fractions - Unit 1[b] (9/11)	1617	661	41	952	824	87	585	71
Fractions - Unit 2 (9/10)	1483	743	50	736	613	83	427	70
Fractions - Unit 3 (17/20)	1430	324	23	1106	955	86	610	64
Fractions - Unit 4 (14/16)	1046	118	11	926	734	79	411	56
Fractions - Unit 5 (14/16)	906	141	16	764	659	86	486	74
Fractions - Unit 6 (9/11)	793	274	35	517	439	85	372	85
Decimal Concepts (15/18)	593	138	23	455	376	83	276	73
Linear Measurement (20/24)	803	181	23	622	427	69	294	69
Area Measurement (10/12)	513	44	9	467	352	75	183	52
Metric Measurement (10/12)	321	40	13	279	265	95	218	82
Totals	11,296	2978	26%	8299	6937	84%		

[a]The percentages in Column B are based on the numbers in Column A. The percentages in Column D are based on the numbers in Column C. The percentages in Column E are based on the posttest score distributions.

[b]Unit 1 - Adding Fractions with Like Denominators
Unit 2 - Adding Mixed Numbers with Like Denominators
Unit 3 - Subtracting Fractions with Like Denominators
Unit 4 - Adding and Subtracting Fractions with Different Denominators
Unit 5 - Multiplying Fractions
Unit 6 - Dividing Fractions

The numbers of students who completed the units are given in Column D. These figures are less than the numbers of eligible students given in Column C for various reasons. Students might have completed the work but did not have posttest scores recorded. One teacher's record book was stolen so some scores for his pupils were missing. Other students started units near the end of the school year and did not finish the units. According to the information the project leaders received from the teachers, however, the main reason for the apparent attrition was the mobility of the student population. The turnover rate in the Target Area schools is higher than the city's average. The percentage of eligible students who completed the units, therefore, does not appear to be lower than expected.

Nine of the units in use in 1972-73 were revisions of materials which had been tried out in 1971-72. Some units had undergone widespread revision while only minor changes were made in others. Table 11 shows a comparison of use and mastery figures for 1971-72 and 1972-73. The project leaders had no explanation for the decline in the percentage who achieved mastery on the unit on Adding and Subtracting Fractions with Different Denominators. The material in Adding Fractions and Mixed Numbers with Like Denominators (1971-72) was divided into two units in 1972-73 as was the unit on Multiplying and Dividing Fractions. The figures given in Table 11 for these units are not strictly comparable but are indicative of the worth of the revisions which were made.

Table 11

Comparison of 1971-72 Units and Revised 1972-73 Units

Unit	1971-72 Total N	1971-72 % with Mastery	1972-73 Total N	1972-73 % with Mastery
Fraction Concepts	307	62%	1293	75%
Adding Fractions with Like Denominators and Adding Mixed Numbers	173	55	824	71
with Like Denominators	a	a	613	70
Subtracting Fractions with Like Denominators	174	57	955	64
Adding and Subtracting Fractions with Different Denominators	114	67	734	56
Multiplying and	102	59	659	74
Dividing Fractions	a	a	439	85
Decimal Concepts	72	58	376	73
Metric Measurement	44	70	225	82

[a]This material was presented in one unit in 1971-72 but was divided into two sections when it was revised for 1972-73.

Summary and Discussion

The Mathematics Basic Skills Development Project, in the three years of its existence, has been very effective in reaching its goals. Remedial materials have been developed to teach secondary students those basic mathematics skills in which they were found to be deficient. The units and their supplementary materials have received pilot usage and have then been revised on the basis of data analysis and student and teacher comments.

The resulting instructional units have been well accepted in the classroom and have shown their value by the percentages of students who were able to achieve mastery after studying the materials. Over 70% of the students reached that goal in seven of the eleven units in general use in 1972-73. Only the units on Area Measurement and Adding and Subtracting Fractions with Different Denominators were mastered by less than 60% of the students, but they still met the objective of having at least 50% of the pupils score 85% or better. Teachers reported that those areas were especially difficult ones for the students.

Of the four units which were pilot tested in 1972-73, two seemed eminently successful. The numbers of students involved in the testing of the units on Multiplying Decimal Numbers and on Addition and Subtraction of Decimal Numbers were fairly small (84 and 119) but the percentages who reached mastery were high (80% and 74%). The other two units, on Liquid Measurement and Dividing Decimal Numbers, should probably undergo more thorough revisions since only 49% and 51% of the students attained the objective that was set for them. Perhaps the objectives for these two less successful units should also be reexamined. It was noted in additional data provided for the project leaders that far fewer students (6%) had pretest mastery in these areas than in the other two areas under trial (37% and 48%).

Although no formal process evaluation was conducted, it is apparent from what is now available that the project has been meeting the schedules and goals it originally set for itself in the development of individualized instructional materials for the remediation of deficiencies in basic mathematics skills at the secondary level.

Recommendations

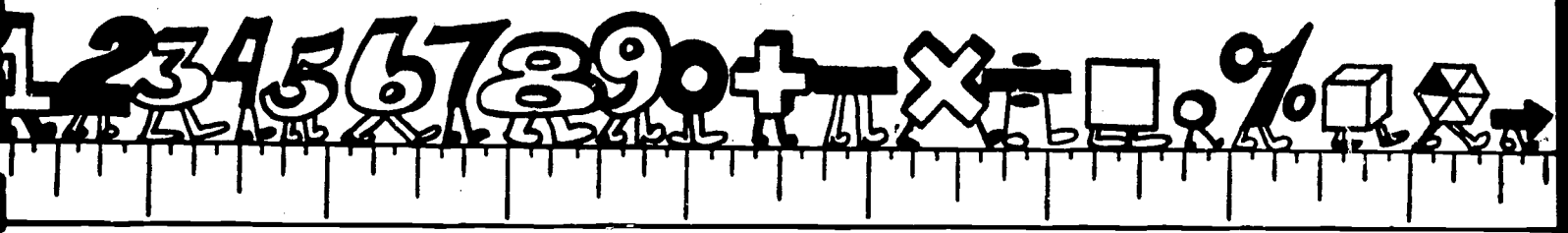
The following recommendations are based only on those aspects of the project which were evaluated in this report. Other important factors such as relative costs and student attitudes were not measured.

1. Continue the developmental phase of the project in areas which still lack sufficient or appropriate materials for the remediation of secondary students' deficiencies in mathematics basic skills.

2. Expand the implementation phase of the project since it has been shown to be successfully meeting the goal of remediation of deficiencies in mathematics basic skills. Continue to explore means of providing the revised versions of the materials to secondary students outside the Target Area who display deficiencies in the skills covered.

3. Make thorough revisions of the units on Liquid Measurement and on Dividing Decimal Numbers based on item analyses and teacher comments.

4. Investigate the drop in 1972-73 in the percentage of students who achieved mastery of the unit on Adding and Subtracting Fractions with Different Denominators.



MATH BASIC SKILLS

INDIVIDUALIZED INSTRUCTIONAL UNITS IN BASIC MATH SKILLS FOR JUNIOR AND SENIOR HIGH SCHOOL STUDENTS.

MINNEAPOLIS PUBLIC SCHOOLS
SPECIAL SCHOOL DISTRICT NO. 1
807 NORTHEAST BROADWAY
MINNEAPOLIS, MINNESOTA 55413

$3\frac{1}{3} \div \frac{2}{3}$ means: *How many ___ in ___ ?*

Here is a picture of $3\frac{1}{3}$
Finish dividing the picture into groups of $\frac{2}{3}$
How many groups of $\frac{2}{3}$ are there? ___

So, $3\frac{1}{3} \div \frac{2}{3} =$ ___

$2\frac{1}{4} \div \frac{1}{4}$ means: *How many ___ in ___ ?*

Here is a picture of $2\frac{1}{4}$
Use circles to divide the picture into groups of $\frac{1}{4}$
How many groups of $\frac{1}{4}$ are there? ___

So, $2\frac{1}{4} \div \frac{1}{4} =$ ___

$3 \div \frac{1}{5}$ means: *How many ___ in ___ ?*

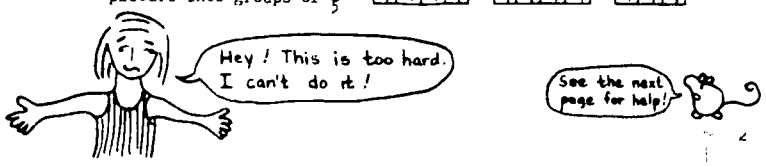
Use circles to divide the picture into groups of $\frac{1}{5}$

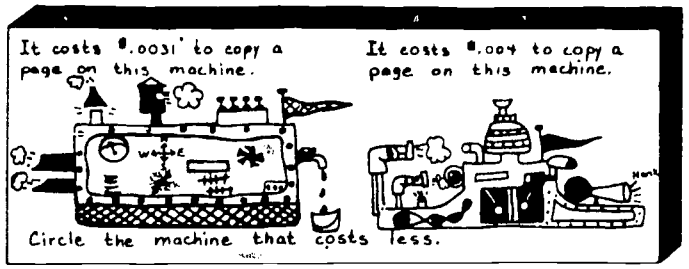
How many groups of $\frac{1}{5}$ are there? ___

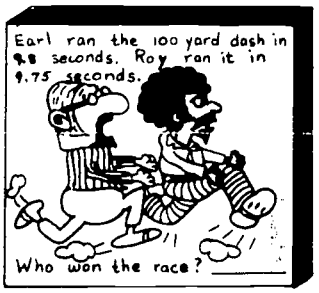
So, $3 \div \frac{1}{5} =$ ___

$2\frac{3}{4} \div \frac{4}{5}$ means: *How many ___ in ___ ?*

Use circles to divide the picture into groups of $\frac{4}{5}$







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INDIVIDUALIZED MASTERY LEARNING SYSTEM

These math materials are designed to teach basic math skills in whole numbers, fractions, decimals, and measurement to students in grades 7-12. They were developed under Title I funds by the Mathematics Basic Skills Development Project of the Minneapolis Public Schools. Each instructional unit was written by a team of junior high math teachers, using specific behavioral objectives. The units were classroom tested in eight "target area" secondary schools and revised on the basis of pretest-posttest data and teacher comments. The research results show that these materials are effective in teaching basic math skills. The low-cost consummable booklets have a low reading level and use cartoon characters and puzzle pages to provide motivation.

DIAGNOSIS AND REMEDIATION

The units have been used as part of an individualized, mastery learning system. A diagnostic test determines whether the student needs the unit. If he does, he works through the instructional booklet at his own speed. The booklets, which are 20 to 50 pages in length, are divided into parts, and at the end of each part the student gets an answer key and checks his work. After completing the booklet, he takes one of three forms of the posttest. If he achieves 85% mastery, he is ready to go on; otherwise there are supplementary puzzles to assist the teacher in providing further help. Then the student takes a different form of the posttest to assess his level of mastery.

HOW TO PURCHASE LOW COST MATERIALS

The student booklets may be purchased in packages of 10. Each package also contains 10 diagnostic tests and 20 posttests (10 of Form A, 5 of Form B, and 5 of Form C). Additional diagnostic tests may be purchased separately in packages of 30. Teacher materials are also available. The unit answer keys, which the student uses to correct his work in the booklet, are sold in four sets:

- Fractions - one answer key for each fractions unit (total of 7)
- Decimals - one answer key for each decimals unit (total of 4)
- Measurement - one answer key for each measurement unit (total of 5)
- Division of Whole Numbers - one unit answer key

For each of these four areas there is also a second package of teacher materials which contains test answer keys, objectives, notes to the teacher, and supplementary puzzles.

Sample Set Available

A sample set contains one copy of each student booklet and one copy of each diagnostic test at $10.00 per set.

_____ 40-1060 Sample Sets x $10.00 = $ _____.

Minneapolis Public Schools

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